VERIFICATION

The undersigned, of the below address, hereby certifies that he/she well knows both the English and Japanese languages, and that the attached is an accurate English translation of the Japanese Patent application filed on August 2, 2002 under No. P2002-226364.

The undersigned declares further that all statements made herein of his/her own knowledge are true and that all statements made on information and belief are believed to be true; and further that these statements were made with the knowledge that willful false statements and the like so made are punishable by fine or imprisonment, or both, under Section 1001 of Title 18 of the United States Code and that such willful false statements may jeopardize the validity of the application or any patent issuing thereon.

Signed this 11th day of August, 2005.

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[Type of Document] Specification

[Title of Invention] Optical components and optical module

[Claim]

[Claim 1] An optical components, comprising:

a nonmetallic ferrule having an opening through which an optical fiber is inserted; and

a metallic holder for covering a portion of the nonmetallic ferrule.

[Claim 2] The optical components according to claim 1,

wherein the metallic holder has a tubular shape.

[Claim 3] The optical components according to claim 2,

wherein the ferrule comprises a first portion having a first diameter, a second portion having a second diameter smaller than the first diameter, and a step portion between the first and second portions, the ferrule being press fitted into the holder by the second portion thereof, the step portion abutting against the holder to position the ferrule.

[Claim 4] The optical components according to one of claims from 1 to 3,

wherein the ferrule is made of zirconia.

[Claim 5] An optical module, comprising:

an optical components according to one of claims from 1 to 4;

a body for enclosing an optical element; and

a metallic sleeve with a cylindrical shape,

wherein a portion of the holder is inserted into the sleeve to position the ferrule, and the sleeve is aligned and fixed to the body.

[Claim 6] The optical module, according to claim 5,

further comprises a connector guide including a pair of side walls, a projections provided on each side walls, a front wall intersecting a predetermined axis, and a hole provided in the front wall to insert the ferrule thereinto,

wherein the connector guide inserts the ferrule into the hole in the front wall and the holder is positioned to abut an inner surface of the front wall.

[Claim 7] The optical module, according to claim 5 or 6,

wherein the optical module is air-tightly sealed.

[Claim 8] The optical module, according to one of claims from 5 to 7,

further includes an optical isolator provided between the ferrule and the semiconductor light-emitting device.

[DETAILED DESCRIPTION OF INVENTION]

[0001]

[Field of the Invention] The present invention relates to an optical component and an optical module.

[0002]

[Prior Art] In one conventional optical module, for example, as disclosed in Japanese Patent Application published as H11-258467,

an optical fiber is mounted on a silicon bench via a nonmetallic ferrule by the passive alignment and is thereby aligned to a laser element.

[0003]

[Subjects to be solved] However, since the passive alignment has restricted the flexibility of the aligning of the optical fiber, it has been hard to obtain a desired optical output power by aligning in fine the optical fiber.

[0004] It is an object of the present invention to provide an optical module which can facilitate the optical alignment.

[0005]

[Means for solving the subjects] An optical component according to the present invention provides a metallic ferrule with an opening through which an optical fiber is inserted and a metallic holder to cover a portion of the ferrule.

[0006] This optical component provides the holder for securing a portion of the nonmetallic ferrule. Since this holder is made of meal, the positioning of the optical fiber can be carried out in precise, which makes the optical alignment in ease.

[0007] It is preferable that the holder has a tubular shape and a portion of the ferrule is preferably press-fitted into the holder. According to this configuration, the optical component may be processed in ease.

[0008] The ferrule of the present optical component preferably has a first portion having a first diameter, a second portion having a second diameter smaller than the first diameter, and a step at a boundary between the first and second portions. The second portion of the ferrule may be press-fitted into the holder to abut the step against the holder

to fix the position thereof. According to this configuration of the ferrule, the relative position of the holder and the sleeve may be enhanced.

[0009] The ferrule is preferably made of zirconia. Since zirconia has a superior property for processing, the zirconia ferrule has excellent dimensional accuracy.

[0010] The optical module according to the present invention may comprise the optical component described above, a body enclosing an optical device, and a tubular metallic sleeve. The portion of the holder is inserted into and fixed to the sleeve, and the sleeve is aligned and fixed to the body.

[0011] Since the optical module provides the optical component and the metallic sleeve, it is possible for the optical component to align by the three-axis active alignment with the body, which enables the optical alignment in ease.

[0012] The optical module may further comprise a connector guide. The connector guide may include a pair of side walls, a projections provided on each side walls and a front wall that intersects an preset axis, and a hole formed in the front wall for inserting the ferrule thereinto. The ferrule is inserted to the hole of the front wall such that the holder abuts on an inner surface of the front wall. To provide the connector guide enables the optical module to mate with the external connector. The positional relation between the connector guide and the optical component may be kept constant by the holder abutting against an inner surface of the front wall of the connector guide.

[0013] The optical module of the present invention is preferably sealed in airtight, which maintains the reliability of the optical device installed within the body in a long time.

[0014] The optical module may further include an isolator between the ferrule of the optical component and the optical device in the body. This configuration prevents an optical reflection at the optical fiber inserted into the hole of the optical fiber, and enhances the transmission characteristic of the module.

[0015]

[Embodiment of the Invention] Preferred embodiments of the present invention will be described with reference to the accompanying drawings. The use of the same symbols in different drawings indicates similar or identical items.

[0016] FIG. 1(a) is a perspective view showing an optical module according to the first embodiment. FIG. 1(b) is a cross sectional view, taken along the line IB-IB in FIG. 1(a).

[0017] As shown in FIG. 1(a), an optical module 1 comprises a body 10, an optical component 30, and a sleeve 40. The body 10 includes a package 12, a semiconductor device such as a laser diode, a laser driver 16, a laser light monitoring device 18 such as light-receiving device, a lens 20, and a plurality of lead terminals 22.

[0018] The package 12 includes a bottom portion 24, a wall portion 26, and a rid 28. The bottom portion 24 and the wall portion 26 are formed integrally. The bottom portion 24 is made of aluminum ceramic. The bottom portion 24 works as a mounting member for mounting a plurality of elements. That is, the semiconductor light-emitting device 14, the driver 16, the semiconductor light-receiving device for monitoring, and the lens 20 are arranged on the bottom portion along a predetermined axis (the Z-axis in FIG. 1(a)). Thus, the light-emitting device 14 is mounted on the bottom portion made of aluminum ceramic, it is prevented to cause a large parasitic capacitance, which appears in the conventional

module where the light-emitting device 14 is mounted on the Si substrate by the passive alignment, whereby the optical output power from the light-emitting device 14 is prevented in the scattering thereof so the optical output characteristic may be stabilized.

[0019] The wall portion 26 may be made of aluminum ceramic. This wall portion 26 includes a pair of side walls 26a, a front wall 26b and a rear wall 26c. The side walls 26a extend along the predetermined axis (Z axis shown in FIG. 1(a)). The front wall 26b and the rear wall 26c intersect with this predetermined axis. A through hole 27 is provided in the front wall 26b. Light from the laser diode 14 passes through the through hole 27. A tubular portion 29 is provided on an outer face of the front wall 26b and is used for mounting a sleeve 40 thereon, as described below. The tubular portion 29 has a first portion and a second portion. The first portion has a larger inside diameter, and the second portion has a smaller inside diameter. A hermetic window 25 is provided in the first portion so as to seal the package 12 therewith. This tubular portion 29 is made of metal, such as Kovar (trademark), to permits the welding of the sleeve 40 to the tubular portion 29, and the tubular portion 29 may be provided co-axially with the through hole 27.

[0020] The rid 28 may be made of metal, such as Kovar. This rid 28 covers an upper opening of the wall portion 26.

[0021] In this body 10, the hermetic window 25 installs in the tubular portion 29, and the rid 28 hermetically seals the wall portion 26 of the package 12 via a seal ring 21. Accordingly, the package 12 is hermetically sealed to form a cavity. The hermetically sealed cavity can maintain high reliability of the laser diode 14 incorporated in the body 10 over a long period.

[0022] The light-emitting device 14 is mounted on an upper surface of the first portion 24. This light-emitting device 14 emits light modulated in response to a modulating signal provided by the driver 16. The light-emitting device may be a semiconductor laser diode.

[0023] The driver 16 is mounted on the first portion 24a to position in side-by-side to and in the rear side of the light-emitting device 14. The driver 16 receives the modulation signal via the lead terminals 22. The driving signal modulates the light-emitting device 14. The driver 16 amplifies the modulation signal to generate the driving signal to provide to the light-emitting device 14.

[0024] The light-receiving device 18 is mounted on a side surface of a mounting member 19 provided on the second portion 24b. Specifically, the mounting member 19, the light-receiving device 18 being fixed thereto, is mounted on the second portion 24 in the rear wall portion 26c to put the driver between the light-emitting device and the mounting member 19. The light-receiving device 18 monitors an emitting status of the light-emitting device. The light-receiving device may be a photodiode.

[0025] The lens 20 is mounted on the first portion 24. Specifically, the lens 20 is mounted at the front side on the first portion 24, to which the light from the light-emitting device is emitted, such that the lens 20 puts the light-emitting device 14 between the driver 16. The lens 20 may be formed from a ball lens by cutting the upper and lower portions of the ball to form upper and lower planes in parallel to each other. Since the lower face is made flat, the lens 20 can be mounted on the first portion 24 with a high accuracy.

[0026] The lead terminals 22 extend outward from the bottom face of the package 12. The optical module 1 can receive signals from the outside through the plurality of lead terminals 22 and can supply signals

to the outside therethrough.

[0027] As shown in FIG. 1(a) to FIG. 2B, the optical component 30 includes a ferrule 32 and a holder 34. The ferrule 32 is made of ceramic, such as zirconia. Since zirconia is suitable for processing, the ferrule 32 made of zirconia has excellent dimensional accuracy. The ferrule 32 includes a first portion 32b having an outside diameter, and a second portion 32a having a diameter smaller than that of the first portion 32b. A step 32c is provided between the second portion 32a and the first portion 32b. A hole 36 passes from the second portion 32a to the first portion 32b, and an optical fiber is inserted into this hole 36. In order to connect the optical module in ease to an external connector, an emitting end of the ferrule 32 is chamfered.

[0028] The holder 34 is made of metal, such as stainless steel. This holder 34 has a tubular outer shape, and the second portion 32a is press-fitted into the holder 34. Thus, the holder 34 and the ferrule 32 are fixed by press-fitting, accordingly, the optical component 30 may be simplified in its manufacturing process. Moreover, since the step 32c of the ferrule 32 abuts on the holder 34, the ferrule 32 can be precisely positioned to the holder 34.

[0029] The configuration of the ferrule 32 is not limited to one example shown in FIGS. 2 in which the ferrule 32 includes the first 32b and second 32a portions and the step 32c. Alternatively, the ferrule 32 may be formed into a shape with a constant diameter as shown in FIG. 3. The end facet 32e of the ferrule 32 may be formed obliquely as illustrated in FIG. 3(b).

[30] Although the ferrule 32 is made of nonmetallic material as described above, the ferrule 32 can be press-fitted to the metallic holder 34 and covered thereby, the YAG laser welding to the metallic

sleeve 40, which will be explained later, may be carrier out.

[0031] The sleeve 40 is made of metal, such as stainless steel, and has a tubular outer shape. The holder 34 is inserted into the sleeve 40, and the optical component 30 is positioned to the sleeve 40 and is fixed to the sleeve 40 by YAG laser welding. Moreover, this sleeve 40 is positioned to the tubular portion 29 provided on the front wall 26b of the package 12 and is welded to the outer surface of front wall 26b with the YAG laser. The optical component 30, the sleeve 40, and the tubular portion 29 align the optical component 30 with the body 10. In this way, the optical fiber is optically coupled via the optical component 30 and sleeve 40 with the light-emitting device 14 incorporated into the body 10.

[0032] Subsequently, description will be made on three-axis active alignment in which the optical component 30 is positioned to the body 10 in X, Y, and Z directions by use of the above-described optical components 30, the sleeve 30, and the tubular portion 29.

[0033] First, preliminary alignment is performed in X, Y, and Z directions so as to obtain a given optical output power. The alignment of the Z direction is executed by sliding the holder 34 of the optical component 30 in the sleeve 40. The alignment of the X and the Y directions are executed by sliding the sleeve 40 on the surface of the tubular portion 29. After the completion of the alignment in the Z direction, the holder 34 of the optical component 30 is secured to the sleeve 40 by laser welding. Welding the holder 34 to the sleeve 40 may cause slight deviation in the X and the Y directions, and then the deviation is corrected in the subsequent alignment of the X and the Y directions. Thereafter, the sleeve 40 is secured to the tubular portion 29 by laser welding. Basically, the alignment in the X and the Y directions is executed so as to find the optimum position thereof. As shown in FIG.

4, the coupling efficiency exhibits small change in response to deviation in the X and the Y directions around the optimum position. Accordingly, the optical module obtains a stable coupling efficiency after the optimum position has been found in the optical alignment in the X and Y directions.

[0034] As shown in FIG. 5, the optical module 1 according to the present embodiment further includes a connector guide 50. FIG. 5(a) is a perspective view showing the optical module 1 with the connector guide 50 attached thereto. FIG. 5(b) is a cross sectional view, taken along the line VB-VB in FIG. 5A. FIG. 5(c) is an enlarged perspective view of the connector guide 50 of FIG. 5(b).

[0035] As shown in FIG. 5, the connector guide 50 has a pair of side surfaces 52, an upper surface 54, a lower surface 56, and a front surface 58 that intersects the Z axis. The connector guide 50 may be a box-shaped member the rear end of which is open.

[0036] The connector guide 50 has projections 52a provided on respective side surfaces 52. These projections 52a extend along the Y direction and are to engage with fingers 77 of the optical connector 70. On the side surfaces 52 are formed with guide ribs 52b extending along the direction to determine an angle to the optical connector 70 when the optical connector 70 is to be mated therewith. The guide rib 52b reaches in the edge thereof the projection 52a and the other end thereof extends to the vicinity of the front face 58. The edge of the rib 52b is tapered, so that the rib 52b can easily fit into a guide groove 78 of the optical connector plug 70. The mating of the optical module 1 with the optical connector 70 will be described later. The front surface 58 has a hole 58a into which the ferrule 32 is inserted.

[0037] This connector guide 50 receives the holder 34 and the sleeve 40 therein with the ferrule 32 inserted into the hole 58a of the front

surface 58. The holder 34 abuts on an inner surface of the connector guide 50, so that the holder 34 is positioned to the front surface 58. As a result, the positional relation between the connector guide 50 and the optical component 30 is kept substantially constant. The distance between the front end of the ferrule 32 and the projection 52a is controlled as shown in FIG. 5 and so does the repulsive force of a spring 75 of the optical connector 70. Accordingly, it is possible to reduce the optical coupling loss between the optical module and the optical connector when the optical connector is mated therewith.

[0038] As shown in FIG. 6, the optical module 1 of the present embodiment is coupled with the optical connector 70 via the connector guide 50. The optical connector 70 may be made of plastics, and may be a type of the so-called EZ-connector.

[0039] As shown in FIG. 6 and FIG. 7, the optical connector 70 includes an optical fiber 71, a connector housing 73 and a sleeve 74. One end of the optical fiber 71 is inserted into and fixed to a ferrule 79. The sleeve 74 positions the ferrule 79. The connector housing 73 has a rear wall having an opening 72 through which the optical fiber 71 passes. A helical spring 75 is located between the sleeve 74 and the rear wall of the connector housing 73, and the optical fiber 71 extends along the center of the helical spring 75.

[0040] The connector housing 73 includes a pair of elastic arms 76 to be mated with the connector guide 50. The arms 76 are located at both side of the connector housing 73. The arms 76 extend along Z direction of the optical axis. The fingers 77 can be engaged with the projections 52a of the guide 50, and are provided on inner surfaces of the arms portions 76. Each finger 77 has a tip tapered to facilitate to mate with the projection 52a. In association with the tapered tips, each projection 52a also has a tapered surface on which the finger

77 abuts. Accordingly, when the connector guide 50 is fitted into the optical connector 70, the projections 52a elastically deform the arms 76 outward to permit the engaging fingers 77 to mate with the projections 52a. The fingers 77 recover their original shape after mating with the projections 52a. This engagement prevents the optical connector 70 from coming off. In particular, since the helical spring 75 is located between the sleeve 74 and an inner wall of the opening 72, the optical connector 70 does not come off due to the helical spring 75 once the projections 52a and the fingers 77 are engaged with each other.

[0041] In addition, each finger 77 has the guide groove 78 shaped to correspond to the position and shape of the rib 52b of the connector guide 50. This guide groove 78 acts to guide the optical connector 70 when the optical connector 70 is mated with the optical module 1. Moreover, after the optical connector 70 is mated with the optical module 1, the guide groove 78 prevent the ferrule 32 from receiving unexpected force in the direction perpendicular to a plane along which the ferrule 32 and the ribs 52b are arranged.

[0042] As shown in FIG. 6, when the optical connector 70 is mated with the optical module 1, the ferrule 32 of the optical module 1 is housed in the sleeve 74 of the optical connector 70. Moreover, the ferrule 79 holds the optical fiber 71 and is inserted into the sleeve 74 and positioned via the sleeve 74.

[0043] Thus, according to the optical module 1 of the present embodiment, the holder 34 is slid along the Z direction relative to the sleeve 40 and positioned thereto. Then the holder 34 is welded to the sleeve 40. The sleeve 40 is slid in the X and the Y directions relative to the tubular portion 29, and then the sleeve 40 is welded to the tubular portion 29. This structure of the optical module allows the fine-tuning of the optical fiber in the three directions. Accordingly,

it is possible to execute the optical alignment to generate a predetermined optical output power.

[0044] As described above, since the optical alignment is carried out in the three-axis active alignment, it is unnecessary to mount a light-emitting device onto a silicon bench, in which the optical alignment is carried out by the passive alignment. Instead, the light-emitting device 14 is mounted on the bottom portion 24 is made of aluminum ceramic. Accordingly, a large parasitic capacitance may be escaped compared with the configuration of the conventional optical module, and unevenness of the optical output power from the light-emitting device may be reduced, which can stabilize the light-emitting characteristic of the optical module, in particular, that in the region over 10 Gbps.

[0045] Furthermore, in the conventional module where the optical alignment is carried out passively, since the optical fiber is abutted against the light-emitting device, it is quite hard to place the light-emitting device apart from the ferrule in the optical module. Since the present configuration of the optical module 1 can use the active alignment, the gap between the light-emitting device 14 and the ferrule 32 can be set widely. Therefore, the conventional module in unable to position the lens between the light-emitting device and the ferrule, the coupling efficiency of the light-emitting device with the optical fiber is limited to about, 10 dB at most. While, the present module 1 may be enhanced in the optical coupling efficiency because the present module is able to position the lens between the light-emitting device 14 and the ferrule 32.

[0046] Moreover, since the ferrule 32 is located apart from the laser diode 14 in the present optical module 1, it is possible to provide the hermetic window 25 therebetween. The hermetic window 25 enables

the hermetic sealing of the body 10, and the reliability of the laser diode 14 can be maintained over a long time.

[0047] The present invention is not limited to the above-described embodiments, and various modifications and changes can be considered.

[0048] For example, the present module may provide an optical isolator 80 between the ferrule 32 in the optical component 30 and the light-emitting device 14 enclosed in the body. FIG. 8 is a cross section showing the optical module 1 that includes an optical isolator 80. The optical isolator 80 is welded with the YAG laser at the input end of the ferrule 32 in the holder 34 of the optical component 30. Accordingly, the optical isolator 80 prevents light reflected in the optical fiber from returning the light-emitting device 14, which enhances the optical transmission characteristics, particularly in the speed over 10 Gbps.

[0049] Moreover, in the present optical module, when the positioning accuracy along the Z direction is achieved, the holder 34 along the Z direction may be slid relative to the tubular portion 29 without using the sleeve 40 to position the holder 34 and the tubular portion 29 to each other in the X and the Y directions. The holder 34 may be welded to the tubular portion 29 directly.

[0050] Although the embodiment describes the optical transmitting module which includes the light-emitting device 14 as an optical element, the optical module may be an optical receiving module which includes a light-receiving device as the optical element.

[0051] [Function of the Invention] According to the present invention, the optical module can be obtained which enables the optical alignment in ease.

[BRIEF DESCRIPTION OF THE DRAWINGS]

[FIG. 1] FIG. 1(a) is a perspective view showing an optical module according to a first embodiment of the present invention, and FIG. 1(b) is a cross section taken along the line IB-IB in FIG. 1(a), in which an optical connector guide is detached thereto;

[FIG. 2] FIG. 2 is a view showing an optical component according to the embodiment;

[FIG. 3] FIG. 3 is a view showing a modified example of the optical component;

[FIG. 4] FIG. 4 is a graph showing the relation of the optical coupling efficiency of the optical module to the deviation in the X and Y directions;

[FIG. 5] FIG. 5(a) is a perspective view showing an optical module according to another embodiment, FIG. 5(b) is a cross section taken along the line VB-VB in FIG. 5(a) (in both figures, a connector guide is mated with the optical module), and FIG. 5(c) is an enlarged perspective view showing the connector guide of FIG. 5(b);

[FIG. 6] FIG. 6(a) is a perspective view showing the optical connector and the optical module according to the first embodiment with the optical connector connected to the optical module, and FIG. 6(b) is a cross section taken along the line VIB-VIB in FIG. 6(a);

[FIG. 7] FIG. 7 is a perspective view showing an optical connector;

[FIG. 8] FIG. 8 is a cross section showing a modified example of the optical module.

[Explanation of Symbols]

1...Optical Module, 10...Body, 14...Light-Emitting Device,

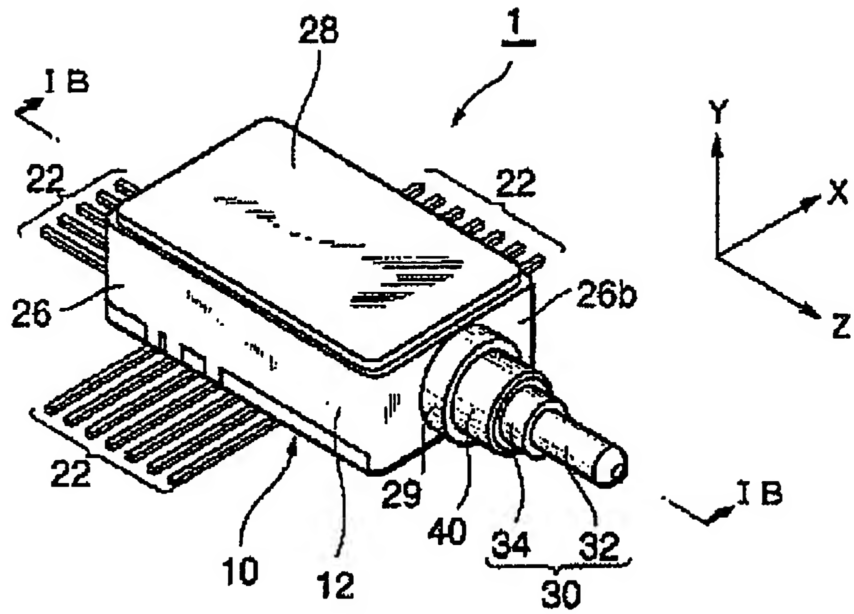
30...Optical Component, 32...Ferrule, 32a... Second Portion, 32b...First Portion, 32c...Step, 34...Holder, 36...Opening, 40...Sleeve, 50...Connector Guide, 52...Side Wall, 52a...Projection, 58...Front Wall, 58a...Opening, 80...Optical Isolator

[Abstract of the Disclosure]

An optical module 1 includes an optical component 30, a body 10 incorporating an optical element 14, and a metallic sleeve 40 having a tubular shape. The optical component 30 includes a nonmetallic ferrule 32 having an optical fiber insertion hole 36, and a metallic holder 34 which covers part of the ferrule 32. In this optical module 1, part of the holder 34 is inserted into the sleeve 40, and is positioned and welded to the sleeve 40. The sleeve 40 is positioned to a tubular portion 29 of the body 10 and welded thereto.

FIG. 1

(a)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IB
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Y
X
Z
26
26b
22
29
40
34
32
30
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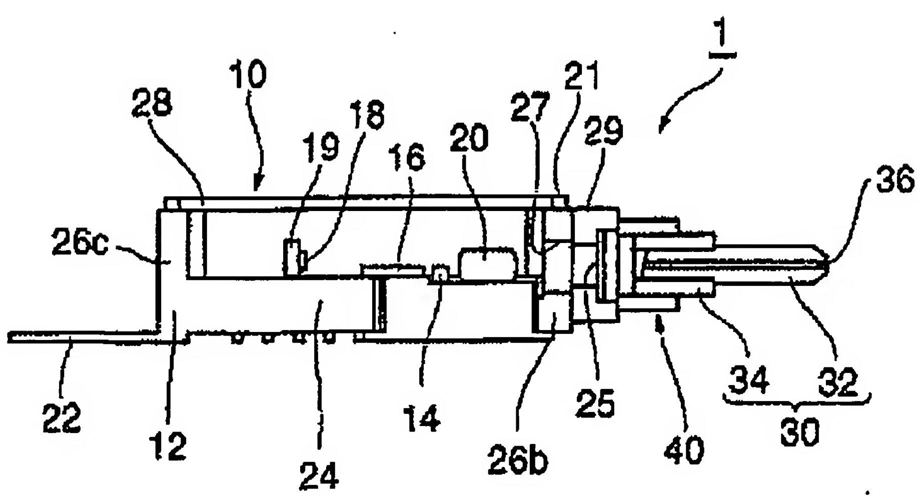
12
IB

(b)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28
19
18
16
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22
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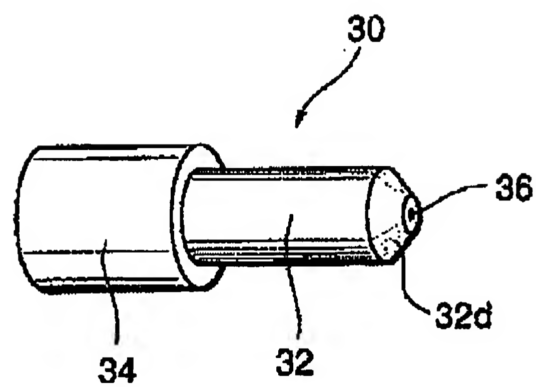
34
32
30

FIG. 2

(a)



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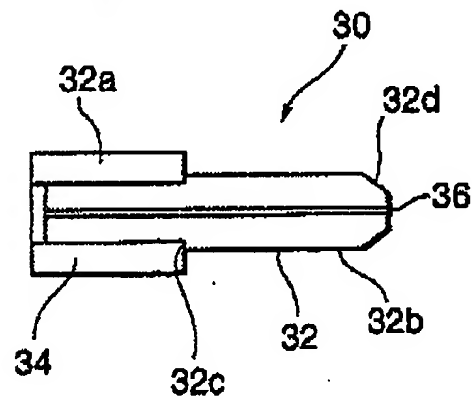
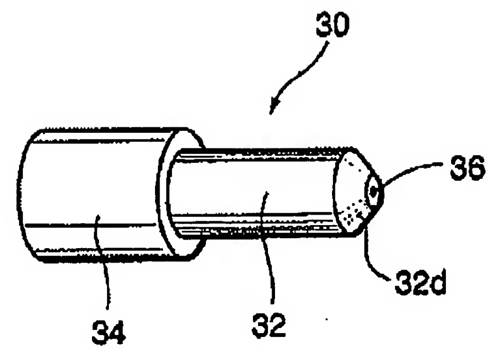


FIG. 3

(a)



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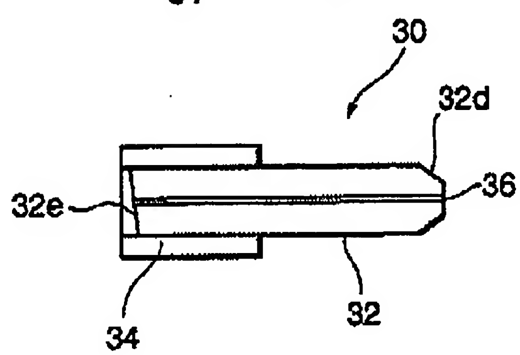
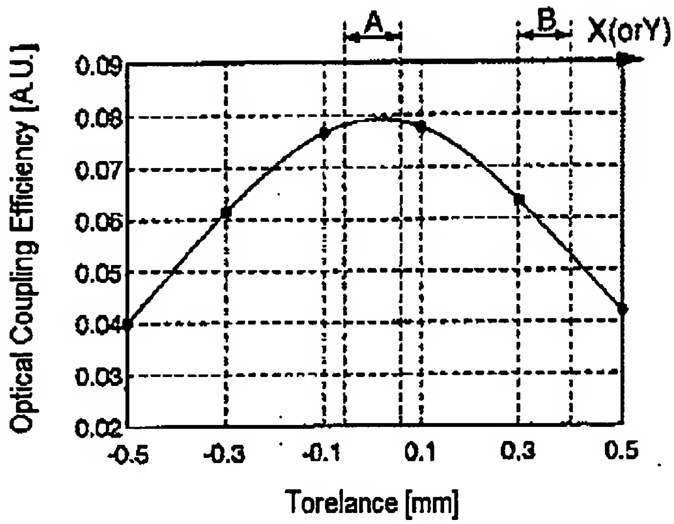


FIG. 4


A
B
X(orY)
Optical Coupling Efficiency [A.U.]
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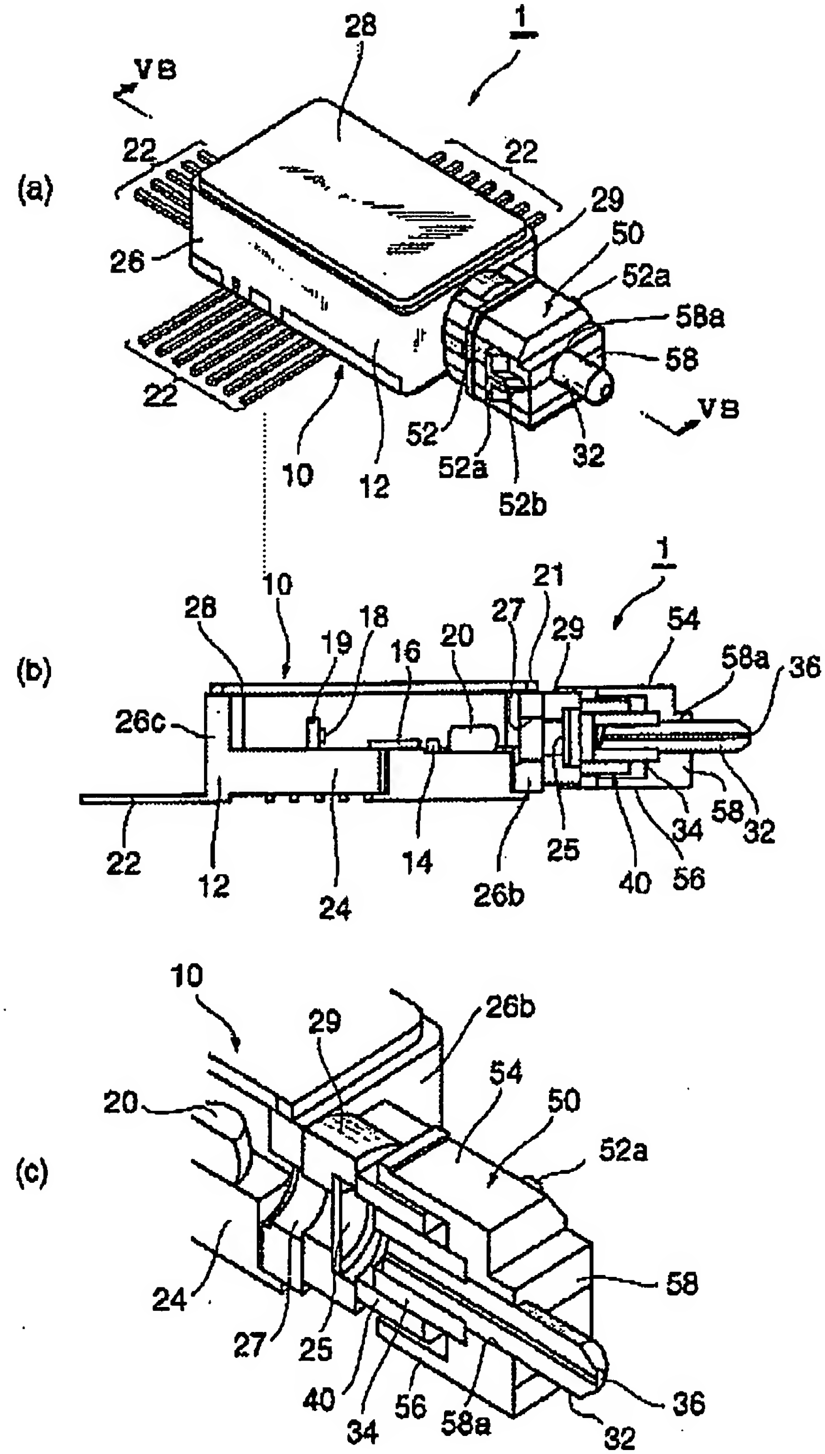
0.08
0.07
0.06
0.05
0.04
0.03
0.02
-0.5
-0.3
-0.1
0.1
0.3
0.5
Torelance [mm]

FIG. 5


(a)
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(b)
1
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19
18
16
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36
26c
22
12
24
14
26b
25
40
34
56
58
32
(c)
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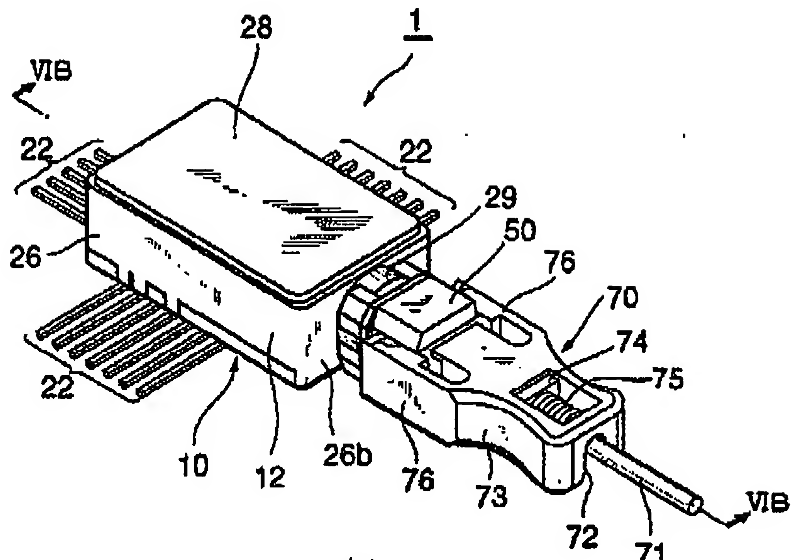
58a
58
36
32

FIG. 6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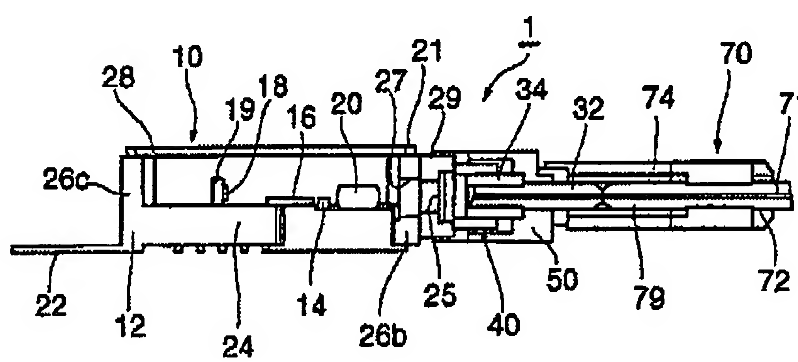
VIB

(a)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40
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79
72

(b)

FIG. 7

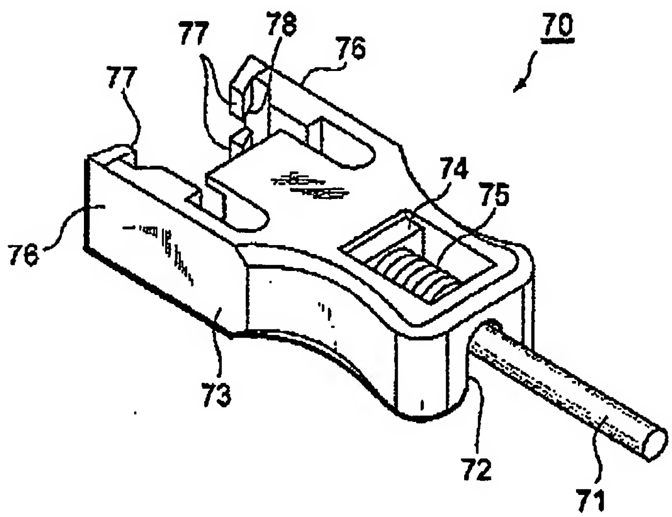

FIG. 8